

IN THE SPECIFICATION

The Examiner objected to the specification and requested correction of the following errors. No new matter has been introduced as a result of the amendments to the specification. A clean version of the substitute specification with the changes identified below is enclosed with this response and incorporated herein by reference.

Please amend the term, high molecular compound, to high molecular weight compound throughout the specification as shown below. Additionally, please amend the term low molecular compound, to low molecular weight compound throughout the specification as shown below. The above amendments are necessary to correct a translation error. Support for the amendment can be found on at least page 13 of the Specification which lists various high molecular weight compounds as examples of high molecular compounds and explains the decomposition of high molecular weight compounds into low molecular weight compounds.

Additionally, typographical errors present in the specification were corrected.

Please amend paragraph [0005] as follows:

In order to cope with this problem, manufacture and usage of plastics, mainly composed of bio-cellulose, derived from natural materials, or starch, natural polyester by fermentation, cellulose based esters of low substitution degree, natural polyesters by fermentation, or aliphatic polyester resins by chemical synthesis, are under investigations as biodegradable plastics. The biodegradable resins are biochemically decomposed by microorganisms into carbon dioxide and water, for example. Thus, even if these biodegradable resins are discarded in the environment, they are readily decomposed into low molecular weight compounds innocuous to environment. Hence, the use of biodegradable resins decreases the adverse effect of disposal on global environment. For these reasons, researches into the use of the biodegradable resins for disposable

products, centered about sundries for our everyday life, goods of hygiene or toys, are currently underway.

Please amend paragraph [0007] as follows:

Moreover, when the biodegradable resins are applied to, for example, practical articles, such as casings of electronic equipment, the resins are required to exhibit high flame retardant properties and durability under high temperature high humidity conditions. For example, with a portable audio product, for example, it is required that physical properties, such as strength, shall be maintained for three to seven years under the conditions of a temperature of 30°C ~~30°C~~, and a relative humidity of 80%.

Please amend paragraphs [0014-0019] as follows:

A resin composition according to the present invention comprises at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

A molded product according to the present invention is obtained on molding a resin composition comprising at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

An electrical product according to the present invention includes, as its constituent, a molded product obtained on molding a resin composition comprising at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

A method for producing the resin composition of the present invention produces the resin composition by compounding at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

With the resin composition of the present invention, in which the phosphorus-containing compound is contained in the biodegradable organic high molecular weight compound, the dehydrating action and the heat shielding effect proper to charring act synergistically when the biodegradable organic high molecular weight compound is subjected to elevated temperatures, thus conferring high flame retardant properties to the biodegradable organic high molecular weight compound.

Moreover, with the resin composition of the present invention, added by the hydrolysis suppressing agent, suppressing the hydrolysis, the rate of hydrolysis of the biodegradable organic high molecular weight compound is slowed down, as a result of which high mechanical strength may be maintained for a time longer than in case no hydrolysis suppressing agent is added. Thus, with the resin composition of the present invention, containing the biodegradable organic high molecular weight compound and the specified flame retardant additive as well as the hydrolysis suppressing agent, both the flame retardant properties and preservation characteristics may be satisfied simultaneously.

Please amend paragraphs [0021-0027] as follows:

Another resin composition according to the present invention comprises at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound and a hydroxide, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one biodegradable organic high molecular weight compound.

Another molded product according to the present invention is obtained on molding at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound and a hydroxide, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

Another electrical product according to the present invention includes, as its constituent, a molded product obtained on molding at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound and a hydroxide, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

Another method for producing the resin composition of the present invention produces the resin composition by compounding at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound and a hydroxide, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

With the other resin composition of the present invention, in which the hydroxide is added as flame retardant additive to the biodegradable organic high molecular weight compound, the hydroxide displays a flame retardant effect by the endothermic effect and by generation of water on decomposition, when the biodegradable organic high molecular weight compound is subjected to elevated temperatures, thus conferring high flame retardant properties to the biodegradable organic high molecular weight compound.

With the other resin composition of the present invention, in which the phosphorus-containing compound is further added to the biodegradable organic high molecular weight compound, the dehydrating action and the heat shielding effect act synergistically, when the biodegradable organic high molecular weight compound is subjected to elevated temperatures thus conferring high flame retardant properties to the biodegradable organic high molecular weight compound.

Moreover, with the other resin composition of the present invention, added by the hydrolysis suppressing agent, suppressing the hydrolysis, the rate of hydrolysis of the biodegradable organic high molecular weight compound is slowed down, as a result of which high mechanical strength may be maintained for a time longer than in case no hydrolysis suppressing agent is added. Thus, with the resin composition of the present invention, containing the biodegradable organic high molecular weight compound and specified flame retardant additive as well as hydrolysis suppressing agent, both the flame retardant properties and preservation characteristics may be satisfied simultaneously.

Please amend paragraphs [0029 - 0034] as follows:

A further resin composition according to the present invention comprises at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound and a hydroxide, and a hydrolysis suppressing agent

suppressing hydrolysis of the at least one biodegradable organic high molecular weight compound.

A further molded product according to the present invention is obtained on molding at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound and a hydroxide, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

A further electrical product according to the present invention includes, as its constituent, a molded product obtained on molding at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound and a hydroxide, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

A further method for producing the resin composition of the present invention produces the resin composition by compounding at least one biodegradable organic high molecular weight compound, a flame retardant additive containing a phosphorus-containing compound and a hydroxide, and a hydrolysis suppressing agent suppressing hydrolysis of the at least one organic high molecular weight compound.

With the further resin composition of the present invention, in which the flame retardant additive containing the nitrogen compound and the hydroxide is contained in the biodegradable organic high molecular weight compound, the flame retardant effect proper to the hydroxide and the flame retardant effect proper to the nitrogen-containing combustion obstructive gas, generated when the biodegradable organic high molecular weight compound is subjected to elevated temperatures, act synergistically, thus conferring high flame retardant properties to the biodegradable organic high molecular weight compound.

Moreover, with the further resin composition of the present invention, added by the hydrolysis suppressing agent, suppressing the hydrolysis, the rate of hydrolysis of the biodegradable organic high molecular weight compound is slowed down, as a result of which high mechanical strength may be maintained for a time longer than in case no hydrolysis suppressing agent is added. Thus, with the further resin composition of the present invention, containing the biodegradable organic high molecular weight compound and the specified flame

retardant additive as well as the hydrolysis suppressing agent, both the flame retardant properties and preservation characteristics may be satisfied simultaneously.

Please amend paragraph [0038-0041] as follows:

Initially, as the resin composition, according to the present invention, a resin composition containing a biodegradable organic high molecular weight compound, a phosphorus-containing compound, operating as a flame-retardant additive, and a hydrolysis suppressing agent, controlling the rate of hydrolysis of the biodegradable organic high molecular weight compound, will be described.

In the following explanation, the biodegradable organic high molecular weight compound, sometimes abbreviated below to the biodegradable high molecular weight compound, means such compound as is decomposed after use into low molecular weight compounds, that is, ultimately decomposed into water and carbon dioxide by participation of microorganisms in nature (Biodegradable Plastics Study Group, ISO/TC-207/SC3). As the biodegradable organic high molecular weight compounds, biodegradable resins, such as aliphatic polyester resins, polysaccharides, peptides, polyvinyl alcohol, polyamides or polyalkylene glycols, exhibiting biodegradable properties, and copolymers containing at least one of these compounds, are preferred. These may be used alone as the biodegradable organic high molecular weight compound. Or, they may be used in combination to derive their respective merits.

Out of the biodegradable organic high molecular compounds, biodegradable aliphatic polyester resins, exhibiting high mixing performance or volume producibility, are preferred. As the biodegradable aliphatic polyester resins, polylactic acids, such as poly-L-lactic acid (PLLA) or random copolymers of L-lactic acid and D-lactic acid, and derivatives thereof, are more preferred. Of course, those compounds classified under aliphatic polyesters, such as, for example polycaprolactone, polyhydroxy lactic ~~acid~~ acid, polyhydroxy valeric acid, polyethylene succinate, polybutylene succinate, polybutylene adipate, polymalic acid, polyglycolic acid, polysuccinate, polyoxalate, polybutylene diglycolate, polydioxanone, polyesters synthesized by fermentation, or copolymers containing at least one of these compounds, may also be used.

As the biodegradable organic high molecular weight compounds, polysaccharides, higher in thermal resistance than the aliphatic polyester resins, may be used. Among polysaccharides, contained in the resin composition, there may be cellulose, starch, chitin, chitosan, dextran,

derivatives thereof and copolymers containing at least one of these compounds. As the polysaccharides, the above compounds may be used alone or in combination. A variety of plasticizers may be added for conferring thermoplastic properties on the polysaccharides

Please amend paragraphs [0043-0045] as follows:

The esterified cellulose, used in the resin composition of the present embodiment, may be prepared by known methods. The esterified cellulose may be prepared by complete acetylation of cellulose followed by partial saponification. The esterified cellulose prepared is added by a plasticizer for improving its moldability. Although there is no particular limitation to the plasticizer provided that it has good biodegradability and high plasticizing performance, low molecular ester-based plasticizers are preferred and phosphates or carboxylates ~~carbonates~~ are more preferred.

Examples of the phosphates include triphenyl phosphate (TPP), tricresylphosphate (TCP), cresyl diphenyl phosphate, octyl diphenyl phosphate, diphenyl biphenyl phosphate, trioctyl phosphate and tributyl phosphate. Examples of ~~carbonates~~ carboxylates include phthalates and citrates. Concrete examples of the phthalates include dimethyl phthalate (DMP), diethyl phthalate (DEP), dibutyl phthalate (DBP), dioctyl phthalate (DOP), diphenyl phthalate (DPP) and diethylhexyl phthalate (DEHP). Concrete examples of the citrates include o-acetyl triethyl citrate (OACTE), o-acetyl tributyl citrate (OACTB), acetyl triethyl citrate and acetyl tributyl citrate.

Other examples of ~~carbonates~~ carboxylates include butyl oleate, methyl acetyl ricinolate and acetyl tributyl citrate.

Please amend paragraphs [0052-0055] as follows:

Even those organic high molecular weight compounds, having biodegradability lowered at a high molecular weight from the value for a low molecular weight, but which is able to become biodegradable on e.g. graft copolymerization with the above exemplified biodegradable organic high molecular weight compound, may be used in the present embodiment. The organic high molecular weight compounds, having low biodegradability at a high molecular weight, may be exemplified by polyethylene, polyacrylic acid derivatives, polypropylene and polyurethane. There is no particular limitation to the molecular weight or terminal groups of these resins, provided that their mechanical strength is sufficient.

The biodegradable organic high molecular weight compound, used in the present embodiment, may be prepared by any suitable known methods. For example, a biodegradable aliphatic polyesters may, for example, be prepared by a lactide method, a method of polycondensation of polyhydric alcohol and polybasic acid, or a method of intermolecular polycondensation of hydroxyl carboxylic acid, having a hydroxyl group and a carboxylic group in a molecule. These methods are given only by way of illustration and are not to be interpreted as limitative of the present invention.

In the present embodiment, a phosphorus-containing compound, having a phosphorus atom in the molecule, is used as a flame-retardant additive. The phosphorus-containing compound, having the phosphorus atom in the molecule, may be compounded (added) to a compound mainly composed of a high molecular material, such as resin, by mixing or fixing. The phosphorus-containing compound, thus added as an additive, operates as a flame-retarder, a stabilizer and as an extender for imparting e.g. the flame-retardant performance, stability and increasing the volume of the biodegradable organic high molecular weight compound to which is added the additive. For example, if a high temperature of, for example, 500°C or higher is given the compound to be added by the additive, the dehydrating action and the heat shielding effect ascribable to charring act synergistically to confer high flame retardant properties to the compound to be added by the additive. Specifically, high flame-retardant performance, satisfying the range from V-0 to V-1, may be imparted if evaluation is carried out by for example the UL94 combustibility test.

The flame-retardant performance obtained when the phosphorus-containing compound and the biodegradable high molecular weight compound are combined together is higher than that obtained when the phosphorus-containing compound and another resin are combined together. The reason is that the temperature of decomposition of the biodegradable high molecular weight compound is close to the temperature at which the phosphorus-containing compound operates as a flame retarder so that the biodegradable high molecular weight compound is more liable to be mixed with the phosphorus-containing compound.

Please amend paragraph [0062-0065] as follows:

The amount of addition of the phosphorus containing compound is preferably such that the proportion of phosphorus atoms in the phosphorus containing compound accounts for not more than 20 parts by weight to 100 parts by weight based on the weight of an ultimate composition composed of the resin, the phosphorus containing compound, flame retarder, hydrolysis suppressing agent and other additives. In case the amount of addition exceeds the upper limit, given above, desired physical properties of the resin cannot be achieved.

There is no particular limitation to the hydrolysis suppressing agent, used in the present embodiment, provided that it is an additive capable of suppressing the hydrolysis of the biodegradable high molecular weight compound. If the hydrolysis suppressing agent, suppressing the hydrolysis of the biodegradable high molecular weight compound, is contained in the resin, the rate of the hydrolysis of the biodegradable high molecular weight compound is delayed, as a result of which high preservation characteristics may be displayed. Specified hydrolysis suppressing agents may be exemplified by compounds exhibiting reactivity with active hydrogen contained in the biodegradable high molecular weight compound. By adding the above compound, it becomes possible to reduce the amount of active hydrogen in the biodegradable high molecular weight compound to prevent the biodegradable high molecular chain from being catalytically hydrolyzed by the active hydrogen. The active hydrogen herein means hydrogen in the bond of oxygen or nitrogen with hydrogen (N-H or O-H bond), (N-H or O-H bond), this hydrogen being higher in reactivity than hydrogen in the carbon-hydrogen bond (C-H bond) (C-H bond). More specifically, the active hydrogen is present in for example the carboxylic group -COOH, -COOH, a hydroxy group -OH, -OH, an amino group -NH₂, -NH₂ or in an amido linkage -NHCO-, -NHCO- in the biodegradable high molecular weight compound.

The compound having reactivity to the active hydrogen in the biodegradable high molecular weight compound may be exemplified by a carbodiimide compound, an isocyanate compound and an oxazoline compound. In particular, the carbodiimide compound is desirable since the compound may be melted and kneaded with the biodegradable high molecular weight compound and addition of a minor quantity thereof is sufficient to suppress hydrolysis effectively.

Please amend paragraph [0068] as follows:

The isocyanate compounds, exhibiting reactivity to active hydrogen in the biodegradable high molecular weight compound, may be enumerated by, for example, 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, m-phenylene diisocyanate, p-phenylene diisocyanate, 4,4'-diphenylmethane diisocyanate, 2,4'-diphenylmethane diisocyanate, 2,2'-diphenylmethane diisocyanate, 3,3'-dimethyl-4,4'-biphenylene diisocyanate, 3,3'-dimethoxy-4,4'-biphenylene diisocyanate, 3,3'-dichloro-4,4'-biphenylene diisocyanate, 1,5-naphthalene diisocyanate, 1,5-tetrahydro naphthalene diisocyanate, tetramethylene diisocyanate, 1,6-hexamethylene diisocyanate, dodecamethylene diisocyanate, trimethyl hexamethylene diisocyanate, 1,3-cyclohexylene diisocyanate, 1,4-cyclohexylene diisocyanate, xylylene diisocyanate, tetramethyl xylylene diisocyanate, hydrogenated xylylene diisocyanate, lysine diisocyanate, isophorone diisocyanate, 4,4'-dicyclohexyl methane diisocyanate or 3,3'-dimethyl-4,4'-dicyclohexyl methane diisocyanate.

Please amend paragraphs [0072-0073] as follows:

There is no limitation to the method for preparing the resin compound of the present embodiment such that any suitable known methods may be used. The method for preparing the resin composition by melt kneading the flame retarder and the hydrolysis suppressing agent to the biodegradable organic high molecular weight compound may be recited as a suitable method.

In the method for preparation by melt kneading, the flame retarder and the hydrolysis suppressing agent are added or mixed before or when melting the biodegradable organic high molecular weight compound. The flame retarder and the hydrolysis suppressing agent may be added separately or simultaneously. If the flame retarder and the hydrolysis suppressing agent are added separately, any one of them may be added initially. In an alternative method, the biodegradable organic high molecular weight compound is melted and thereafter the flame retarder or the hydrolysis suppressing agent is added and mixed. The resulting composition is remelted together and the remaining one of the hydrolysis suppressing agent and the flame retarder is added and mixed.

Please amend paragraph [0087] as follows:

The resin composition of the present embodiment may be processed in known manner. For example, the resin composition may be irradiated with active energy rays for suppressing

hydrolysis of the biodegradable high molecular weight compound contained in the resin composition.

Please amend paragraphs [0089-0091] as follows:

The active energy rays may be illuminated using known illuminating units, such as, for example, UV illuminating devices or electron accelerators. There is no particular limitation to the exposure and intensity of exposure as long as hydrolysis of the biodegradable high molecular weight compound may effectively be delayed with the exposure and intensity of exposure used for the resin composition of the present embodiment. In the case of electron beam, the acceleration voltage is desirably of the order of 100 to 5000 kV, while the exposure is desirably of the order of 1 kGy.

The molded products, obtained on molding the resin composition of the present embodiment, may be put to a variety of uses. The molding method, used for preparing molded products, may be enumerated by pressure forming, film forming, extrusion or injection molding. Of these, the injection molding is most desirable. Specifically, the injection molding is carried out as conventionally, using a uniaxial extruder, a multi-axial extruder or a tandem extruder. The injection molding may also be carried out, as conventionally, using known injection molding machines, such as an in-line screw injection extruder, a multi-layer injection molding machine or a double-head injection molding machine. There is no particular limitation to the methods for preparing molded products by molding the resin composition, and any of known molding methods may be used.

With the resin composition, containing the biodegradable organic high molecular weight compound, the phosphorus-containing compounds, displaying high flame-retardant properties, when combined with the biodegradable organic high molecular weight compound, and the hydrolysis suppressing agent, it is possible to achieve compatibility between extremely high flame retardant properties, satisfying the range of from V0 to V1, when evaluation is made by e.g. a UV combustibility test, and excellent preservation characteristics, which will sufficiently assure the use of the resin composition as a feedstock for a casing for an electrical product.

Please amend paragraph [0097] as follows:

Initially, the case of a biodegradable organic high molecular weight compound, employing an aliphatic polyester resin, will be described.

Please amend paragraph [0100] as follows:

As for kneading conditions, a MINIMAX-MIXRUDER, manufactured by TOYO SEIKI SHA, was used as a kneader. With the nozzle temperature set to 170 to ~~175°C, 175°C~~, the torque set to 4 to 6 kg and with the time of residence set to three seconds or less, an additive was added to the resin by kneading. The resin composite material, thus produced, was pulverized, and subjected to press working at ~~170°C 170°C~~, under a pressure of ~~300 kg/cm², 300 kg/cm²~~, to form a plate 1.0 mm in thickness. The plate was cut to measurement test pieces each of a size of 12.7 mm_x_12.7 mm. The composition of the test pieces of Examples 1 to 7 and Comparative Examples 1 to 5 are shown in Table 1.

Please amend paragraph [0114] as follows:

The molded product, prepared using the resin composition of the present embodiment, is required to possess preservation characteristics to a certain extent, for use as a molded article in e.g. a casing of an electrical apparatus, even though the molded product is biodegradable. In this consideration, the preservation characteristics at elevated temperature and humidity were evaluated. For this evaluation, each sample was preserved for 100 hours, at a temperature of ~~80°C 80°C~~ and at a relative humidity of 80%, and the shape as well as the molecular weight of the sample after lapse of this time duration was measured. The same test pieces as those used in the above combustion test were used. The test pieces which were not problematical in shape and had a molecular weight upholding ratio from the pre-evaluation value of 80% or higher were evaluated ~~o, smaller~~, and those which failed to meet this requirement were evaluated x. The molecular weight was evaluated by the CPC (Gel Permeation Chromatography). The following Table 1 shows the results of the combustion and preservation tests of the Examples 1 to 7 and the Comparative Examples 1 to 5. Meanwhile, in the following table, [UL94-V1; o] denotes that the sample in question is the 94V-1 approved material, while [UL94-V1; x] denotes that the sample in question is not the 94V-1 approved material.

Please amend paragraph [0118] as follows:

Next, the case of employing polysaccharides as the biodegradable organic high molecular weight compound will be scrutinized.

Please amend paragraphs [0127-0128] as follows:

As the resin composition according to the present invention, a resin composition, containing a biodegradable organic high molecular weight compound, a phosphorus-containing compound and a hydroxide, operating as flame retardant additives, and a hydrolysis suppressing agent, adjusting the rate of hydrolysis of the biodegradable organic high molecular weight compound, will now be described.

The biodegradable organic high molecular weight compound, constituting this resin composition, may be the same as that already described, and hence the description is dispensed with.

Please amend paragraph [0130] as follows:

When a hydroxide is contained as the flame retardant additive in the biodegradable resin, and the biodegradable organic high molecular weight compound is subjected to an elevated temperature, such as a temperature of approximately 500°C, ~~500°C~~, the hydroxide yields water, at the same time as it absorbs heat generated on combustion of the resin and is decomposed. Thus, flame retardant properties are demonstrated by the endothermic action and water generation.

Please amend paragraph [0131] as follows:

As the hydroxide, a component of the flame retardant additive, such a compound containing a hydroxyl group in its molecule, and capable of yielding water on heating, may be used. Specifically, the hydroxides are metal hydroxides containing metal elements in the composition. Concrete examples of the hydroxides include those mainly composed of at least one of aluminum hydroxide, magnesium hydroxide, calcium hydroxide, zinc hydroxide, cerium hydroxide, iron hydroxide, copper hydroxide, titanium hydroxide, barium hydroxide, beryllium hydroxide, manganese hydroxide, strontium hydroxide, zirconium hydroxide, gallium hydroxide, calcium aluminate hydrates (3CaO·Al₂O₃·6H₂O), ~~(3CaO·Al₂O₃·6H₂O)~~ and hydrotalcite (Mg₆Al₂(OH)₁₆CO₃·4H₂O), ~~(Mg₆Al₂(OH)₁₆CO₃·4H₂O)~~. Of these, aluminum hydroxide, magnesium hydroxide and calcium hydroxide are preferred.

Please amend paragraph [0136] as follows:

When the phosphorus-containing compound is used in combination with the biodegradable high molecular weight compound, a higher flame retardant performance may be

achieved than when the phosphorus-containing compound is combined with other resins. The reason is presumably that the temperature of decomposition of the biodegradable high molecular weight compound is close to the temperature at which the phosphorus-containing compound acts as the flame retarder and hence the biodegradable high molecular weight compound may readily be mixed with the phosphorus-containing compound.

Please amend paragraph [0145-0146] as follows:

With the flame retardant additive containing both the hydroxide and the nitrogen-containing gas, the flame retardant performance proper to the hydroxide and the flame retardant effect achieved by the nitrogen-containing combustion obstructive gases, generated on decomposition of the nitrogen compound, act synergistically when the biodegradable organic high molecular weight compound is subjected to elevated temperatures, for example, a temperature not lower than 500°C. Specifically, when a molded product of the biodegradable resin composition of the present embodiment, containing the flame retardant additive, is heated, the nitrogen oxide based gas (N_xO_y based gas) generated by heating the nitrogen compound reacts with water generated on heating the hydroxide to yield nitric acid. By the thermal oxidation of nitric acid, generated by this reaction, the high molecular weight compound, such as biodegradable resin, is converted into non-combustible materials, such as CO_2 or H_2O , thus imparting high flame retardant properties. Hence, by using the hydroxide and the nitrogen compound together as the flame retardant additive, it is possible to impart higher flame retardant properties to the biodegradable organic high molecular weight compound than in case the hydroxide is used by itself.

The nitrogen compound, used as flame retardant additive, may, for example, be a compound containing at least a nitrogen oxide of the formula of N_xO_y , where x and y are natural numbers, in its composition. For example, a non-metallic nitric acid compound and/or a non-metallic nitrous acid compound may be used. Examples of the nitrogen compound include phosphoric esters ($RONO_2$), such as acetyl nitrate ($C_2H_3NO_4$), aniline nitrate ($C_6H_8N_2O_3$), ethyl nitrate ($C_2H_5ONO_2$), butyl nitrate ($C_4H_9ONO_2$), isoamyl nitrate ($(CH_3)_2CHCH_2CH_2ONO_2$), isobutyl nitrate ($(CH_3)_2CHCH_2ONO_2$) or isopropyl nitrate ($(CH_3)_2CHONO_2$), ammonium nitrate (NH_4NO_3), guanidine nitrate ($CH_6N_4O_3$), cellulose

nitrate acetate (nitroacetyl cellulose), cellulose nitrate (nitrocellulose), urea nitrate, hydrodinium nitrate ($\text{N}_2\text{H}_5\text{NO}_3$), hydroxylammonium nitrate ($(\text{NH}_3\text{O})\text{NO}_3$), and benzene diazonium nitrate ($\text{C}_6\text{H}_5\text{N}_3\text{O}_3$), and nitrous esters (RONO), such as ammonium nitrite, ethyl nitrite, methyl nitrite, propyl nitrite, butyl nitrite, isobutyl nitrite and isoamyl nitrite. The aforementioned nitrogen compounds may be used either singly or in combination.

Please amend paragraph [0149-0152] as follows:

The amount of addition of the hydroxide and the nitrogen compounds is preferably 1 to 50 parts by weight of the nitrogen compound and 20 to 120 parts by weight of the hydroxide, to 100 parts by weight of the organic high molecular weight compound of interest. If the amount of the nitrogen compound is less than 1 part by weight, the aforementioned effect cannot be displayed sufficiently. If the amount exceeds 50 parts by weight, the mechanical strength, for example, of the organic high molecular weight compound, as the target system of addition, tends to be deteriorated. The amount of addition of the nitrogen compound is more preferably 1 to 20 parts by weight. If, on the other hand, the amount of addition of the hydroxide is less than 20 parts by weight, the aforementioned effect cannot be displayed sufficiently. If the amount of addition of the hydroxide exceeds 120 parts by weight, there may be a case where undesirably the strength, for example, of the high molecular weight compound as the system for addition cannot be maintained. An optimum amount of addition of the hydroxide is 30 to 100 parts by weight.

There is also no particular limitation to the amount of the hydrolysis suppressing agent used in the present embodiment, provided that the hydrolysis suppressing agent is an additive which suppresses hydrolysis of the biodegradable high molecular weight compound. With content of the hydrolysis suppressing agent, suppressing hydrolysis of the biodegradable high molecular weight compound, the rate of hydrolysis of the biodegradable high molecular weight compound is delayed, thus providing high preservation characteristics that high mechanical strength or impact strength may be maintained for an extended period of time.

Specified hydrolysis suppressing agents may be exemplified by compounds exhibiting reactivity with active hydrogen contained in the biodegradable high molecular weight compound, as those used in the aforementioned resin composition. By adding the above compound, it becomes possible to reduce the amount of active hydrogen in the biodegradable high molecular

weight compound to prevent the biodegradable high molecular chain from being catalytically hydrolyzed by the active hydrogen. The active hydrogen herein means hydrogen in the bond of oxygen or nitrogen with hydrogen (N-H or O-H bond), (N-H or O-H bond), this hydrogen being higher in reactivity than hydrogen in the carbon-hydrogen bond (C-H bond), (C-H bond). More specifically, such active hydrogen is present in for example the carboxylic group -COOH, -COOH, a hydroxy group -OH, -OH, an amino group -NH₂, -NH₂ or in an amido linkage -NHCO-, -NHCO- in the biodegradable high molecular weight compound.

The compound having reactivity to the active hydrogen in the biodegradable high molecular weight compound may be exemplified by a carbodiimide compound, an isocyanate compound and an oxazoline compound. In particular, the carbodiimide compound is desirable since the compound may be melted and kneaded with the biodegradable high molecular weight compound and it is sufficient to add only a small amount of the compound to suppress hydrolysis effectively.

Please amend paragraphs [0154-0157] as follows:

There is also no particular limitation to the sorts or the amounts of the hydrolysis suppressing agent. The rate of biodegradation and further the mechanical strength of the molded product may be adjusted by suitably adjusting the sorts or the amounts of the hydrolysis suppressing agent, and hence the sorts or the amounts of the hydrolysis suppressing agent may be determined depending on the targeted ultimate product. For example, the hydrolysis suppressing agent may be added in an amount not more than 20 parts by weight and preferably in an amount not more than 13 parts by weight to 100 parts by weight of the organic high molecular weight compound.

There is no limitation to the method for preparing the resin composition of the present embodiment, such that any suitable known method may be used. Such a method consisting in melting the flame retardant additive and the hydrolysis suppressing agent and mixing the resulting product to the biodegradable organic high molecular weight compound may be recited as a preferred method for preparing the resin composition.

The method by melting and kneading is carried out by adding the flame retardant additive and the hydrolysis suppressing agent, before or when melting the biodegradable organic high molecular weight compound, and by mixing the resulting mass. The flame retardant additive and

the hydrolysis suppressing agent may be added simultaneously or separately. If the flame retarder and the hydrolysis suppressing agent are added separately, any one of them may be added initially. In an alternative method, the biodegradable organic high molecular weight compound is melted and thereafter the flame retarder or the hydrolysis suppressing agent is added and mixed. The resulting composition is re-melted together and the remaining one of the hydrolysis suppressing agent and the flame retarder is added and mixed. The hydroxide, phosphor-containing compound and the nitrogen compound, as the flame retardant additive, may be added simultaneously or separately. The flame retardant additive used may also be compounded of constituent components.

Please amend paragraph [0164] as follows:

The active energy rays may be illuminated using known devices. Examples of the known devices include UV illuminating devices and electron accelerators. There is no limitation to the radiation dose and the radiation intensity provided that radiation dose and radiation intensity are of such values as to effectively delay the hydrolysis of the biodegradable high molecular weight compound. For example, in the case of the electron beam, the acceleration voltage of the order of 100 to 5000 kV and the radiation dose of the order of 1 kGy or higher are preferred.

Please amend paragraph [0172] as follows:

In an experiment 3, the case of using an aliphatic polyester resin, as a biodegradable organic high molecular weight compound, is scrutinized.

Please amend paragraph [0175] as follows:

As for kneading conditions, a MINIMAX-MIXRUDER, manufactured by TOYO SEIKI SHA was used as a kneader. With the nozzle temperature set to 170 to ~~175°C.~~ 175°C., the torque set to 4 to 6 kg and with the time of residence set to three seconds or less, an additive was added to the resin by kneading. The resin composite material, thus produced, was pulverized, and subjected to press working at ~~170°C.~~ 170°C. under a pressure of 300 kg/cm², to form a plate 1.0 mm in thickness. The plate was cut to measurement test pieces each of a size of 12.7 mm_x_12.7 mm. The composition of the test pieces of Examples 22 to 42 and Comparative Examples 14 to 16 are shown in Table 1.

Please amend paragraph [0189] as follows:

The molded product, prepared using the resin composition of the present embodiment, is required to possess preservation characteristics to a certain extent, for use as a molded article in e.g. a casing of an electrical apparatus, even though the molded product is biodegradable. In this consideration, the preservation characteristics at elevated temperature and humidity were evaluated. For this evaluation, each sample was preserved for 100 hours, at a temperature of ~~80°C~~ ~~80°C~~ and at a relative humidity of 80%, and the shape as well as the molecular weight of the sample after lapse of this time duration was measured. The same test pieces as those used in the above combustion test were used. The test pieces which were not problematical in shape and had a molecular weight upholding ratio from the pre-evaluation value of 80% or higher were evaluated o and those which failed to meet this requirement were evaluated x. The molecular weight was evaluated by the CPC (Gel Permeation Chromatography). The following Table 3 shows the results of the combustion and preservation tests of the Examples 22 to 42 and the Comparative Examples 14 to 16. Meanwhile, in the following table, [UL94-V1; o] ~~[UL94-V1; smallcircle]~~ denotes that the sample in question is the 94V-1 approved material, while [UL94-V1; x] denotes that the sample in question is not the 94V-1 approved material.

Please amend paragraph [0193] as follows:

It is seen from the results of the above experiment 3 that, by mixing the hydroxide and the phosphorus-containing compound, as flame retardant agents, and the hydrolysis suppressing agent, to the biodegradable aliphatic polyester, flame retardant performance and the preservation characteristics may be achieved simultaneously.

Please amend paragraphs [0204-0210] as follows:

Next, a resin composition, containing a biodegradable organic high molecular weight compound, a phosphorus containing compound and a hydroxide, as flame retardant additives, and a hydrolysis suppressing agent, adjusting the rate of hydrolysis of the high molecular weight compound, will be described as a resin composition of the present invention.

As the biodegradable organic high molecular weight compound, making up the resin composition, biodegradable resins are preferred, as in the previous embodiment. These biodegradable resins may be enumerated by any one of biodegradable polyester resins, polysaccharides, peptides, polyvinyl alcohols, polyamides or polyalkylene glycols, or at least one of the aforementioned compounds. Although the biodegradable organic high molecular weight

compound may be used alone, they may also be used in combination for deriving the merits proper to the respective compounds.

In the resin composition of the present embodiment, the biodegradable aliphatic polyester resins, having high mixing performance and volume producibility, belonging to the biodegradable organic high molecular weight compounds, may preferably be used. As the aliphatic polyester resins, polylactic acids, such as poly-L-lactic acid (PLLA) or a random copolymer of L-lactic acid and D-lactic acid, or derivatives thereof, are more preferred. Other compounds classified under aliphatic polyester, such as polycaprolactone, polyhydroxy lactic acid, polyhydroxy valeric acid, polyethylene succinate, polybutylene succinate, polybutylene adipate, polymalic acid, polyglycolic acid, polysuccinate, polyoxalate, butylenes polydiglicolate, polydioxanone, polyester synthesized by fermentation, and a copolymer containing at least one of these, may also be used. As aliphatic polyester resins, the above compounds may be used, either singly or in combination. The polyesters synthesized by fermentation may be enumerated by 3-hydroxybutyrate (3HB), 3-hydroxyvalerate (3HV) and copolymers thereof. As the aliphatic polyester resins, the above compounds may be used either single or in combination.

The peptides may be enumerated by collagen, casein, fibrin and gelatin, only by way of examples.

Among the polyamides, there are, for example, nylon4 and nylon2/nylon6 copolymers.

The organic high molecular weight compound, which are biodegradable at a low molecular weight but which are low in biodegradability at a high molecular weight, may also be used in the present embodiment, provided that such compound may become biodegradable when graft copolymerized with the aforementioned biodegradable high molecular weight compound. Among the organic high molecular weight compounds, which are low in biodegradability at a high molecular weight, there are, for example, polyethylene, polyacrylic acid derivatives, polypropylene and polyurethane. There is no particular limitation to the molecular weight or the terminal group of these resins, provided that sufficient mechanical strength may be achieved.

The biodegradable organic high molecular weight compound, as used in the present embodiment, may also be prepared by known methods. For example, the biodegradable aliphatic polyester may be prepared by a lactide method, polycondensation of polyhydric alcohols and

polybasic acids, or by intermolecular polycondensation of hydroxycarboxylic acid, containing a hydroxyl group and a carboxylic group, only by way of examples.

Please amend paragraph [0214] as follows:

The flame retardant additives may be compounded (added) to the target system of addition, mainly composed of a high molecular material, such as resin, by mixing or fixing. The flame retardant additive, added to the resin composition, acts as a flame retarder, a stabilizer and as an extender, to confer flame retardant properties, stability and extensibility to the biodegradable organic high molecular weight compound, which is the target system of addition of the present invention. When the target system of addition is subjected to an elevated temperature, such as a temperature exceeding 500°C, 500°C,—as an example, the nitrogen oxide based gas (NxOy based gas), generated by heating of the hydroxide, is reacted with water, generated by heating of the hydroxide. By the action of thermal oxidation of nitric acid, generated by this reaction, the high molecular weight compound, such as biodegradable resin, as the target system of addition, is modified into a non-combustible material, such as CO2 or H2O, thereby conferring high flame retardant properties. Thus, high flame retardant properties may be realized by using the hydroxide and the phosphorus compound, as the flame retardant additive, such that it becomes possible to confer high flame retardant performance, satisfying the range of V-0 to V-1, when evaluation is made by for example a UL94 combustibility test.

Please amend paragraph [0216] as follows:

As the hydroxide, which is a compound containing hydroxyl groups in its molecule, such compound which yields water on heating may be used. Concrete examples of hydroxides include metal hydroxides containing a metal element in the composition. As the hydroxide, such compounds essentially composed of at least one of aluminum hydroxide, magnesium hydroxide, calcium hydroxide, zinc hydroxide, cerium hydroxide, iron hydroxide, copper hydroxide, titanium hydroxide, barium hydroxide, beryllium hydroxide, manganese hydroxide, strontium hydroxide, zirconium hydroxide, gallium hydroxide and calcium aluminate hydrates (3CaO·Al2O3·6H2O), (3CaO·Al2O3·6H2O),—hydrotalcite ((MgAl2(OH)16CO3·4H2O), (MgAl2(OH)16CO3·4H2O). Of these, aluminum hydroxide, magnesium hydroxide and calcium hydroxide are preferred.

Please amend paragraph [0220] as follows:

The nitrogen compound, used as flame retardant additive, may, for example, be a compound containing, in its composition, at least a nitrogen oxide of the formula of N_xO_y , where x and y are natural numbers. For example, a non-metallic nitric acid compound and/or a non-metallic nitrous acid compound, may be used. Examples of the nitrogen compound include phosphoric esters ($RONO_2$), such as acetyl nitrate ($C_2H_3NO_4$), aniline nitrate ($C_6H_8N_2O_3$), ethyl nitrate ($C_2H_5ONO_2$), butyl nitrate ($C_4H_9ONO_2$), isoamyl nitrate ($(CH_3)_2CHCH_2CH_2ONO_2$), isobutyl nitrate ($(CH_3)_2CHCH_2ONO_2$) or isopropyl nitrate ($(CH_3)_2CHONO_2$), ammonium nitrate (NH_4NO_3), guanidine nitrate ($CH_6N_4O_3$), cellulose nitrate acetate (nitroacetylcellulose), cellulose nitrate (nitrocellulose), urea nitrate, hydrodinium nitrate ($N_2H_5NO_3$), hydroxylammonium nitrate ($(NH_3O)NO_3$), and benzene diazonium nitrate ($C_6H_5N_3O_3$), and nitrous esters ($RONO$), such as ammonium nitrite, ethyl nitrite, methyl nitrite, propyl nitrite, butyl nitrite, isobutyl nitrite and isoamyl nitrite. The aforementioned nitrogen compounds may be used either singly or in combination.

Please amend paragraphs [0224-0227] as follows:

The amount of addition of the hydroxide and the nitrogen compounds is preferably 1 to 50 parts by weight of the nitrogen compound and 20 to 120 parts by weight of the hydroxide, based on 100 parts by weight of the organic high molecular weight compound of interest. If the amount of the nitrogen compound is less than 1 part by weight, the aforementioned effect cannot be displayed sufficiently. If the amount exceeds 50 parts by weight, the mechanical strength, for example, of the organic high molecular weight compound, as the target system of addition, tends to be deteriorated. The amount of addition of the nitrogen compound is more preferably 1 to 20 parts by weight. If, on the other hand, the amount of addition of the hydroxide is less than 20 parts by weight, the aforementioned effect cannot be displayed sufficiently. If the amount of addition of the hydroxide exceeds 120 parts by weight, there may be a case where undesirably the strength, for example, of the high molecular weight compound as the system for addition cannot be maintained. An optimum amount of addition of the hydroxide is 30 to 100 parts by weight.

There is also no particular limitation to the amount of the hydrolysis suppressing agent used in the present embodiment, provided that the hydrolysis suppressing agent is an additive

which suppresses hydrolysis of the biodegradable high molecular weight compound. With content of the hydrolysis suppressing agent, suppressing hydrolysis of the biodegradable high molecular weight compound, the rate of hydrolysis of the biodegradable high molecular weight compound is delayed, thus providing high preservation characteristics that high mechanical strength or impact strength may be maintained for an extended period of time.

Specified hydrolysis suppressing agents may be exemplified by compounds which, similarly to those used in the aforementioned resin composition, exhibit reactivity with active hydrogen contained in the biodegradable high molecular weight compound. By adding the above compound, it becomes possible to reduce the amount of active hydrogen in the biodegradable high molecular weight compound to prevent the biodegradable high molecular chain from being catalytically hydrolyzed by the active hydrogen. The active hydrogen herein means hydrogen in the bond of oxygen or nitrogen with hydrogen (N-H or O-H bond), (N-H or O-H bond), this hydrogen being higher in reactivity than hydrogen in the carbon-hydrogen bond (C-H bond), (C-H bond). More specifically, such active hydrogen is present in for example the carboxylic group: -COOH, -COOH, a hydroxy group -OH, -OH, an amino group: -NH₂, -NH₂ or in an amido linkage: -NHCO-, -NHCO- in the biodegradable high molecular weight compound.

Specified hydrolysis suppressing agents may be exemplified by compounds which, similarly to those used in the aforementioned resin composition, exhibit reactivity with active hydrogen contained in the biodegradable high molecular weight compound. By adding the above compound, it becomes possible to reduce the amount of active hydrogen in the biodegradable high molecular weight compound to prevent the biodegradable high molecular chain from being catalytically hydrolyzed by the active hydrogen. The active hydrogen herein means hydrogen in the bond of oxygen or nitrogen with hydrogen (N-H or O-H bond), this hydrogen being higher in reactivity than hydrogen in the carbon-hydrogen bond (C-H bond). More specifically, such active hydrogen is present in for example the carboxylic group: -COOH, a hydroxy group -OH, an amino group: --NH₂ or in an amido linkage: --NHCO-- in the biodegradable high molecular weight compound.

The compound having reactivity to the active hydrogen in the biodegradable high molecular weight compound may be exemplified by a carbodiimide compound, an isocyanate compound and an oxazoline compound. In particular, the carbodiimide compound is desirable

since the compound may be melted and kneaded with the biodegradable high molecular weight compound and it is sufficient to add a small amount thereof to suppress hydrolysis more effectively.

Please amend paragraphs [0229-0231] as follows:

There is also no particular limitation to the sorts or the amounts of the hydrolysis suppressing agent. Since the rate of biodegradation and further the mechanical strength of the molded product may be adjusted by suitably adjusting the sorts or the amounts of the hydrolysis suppressing agent, the sorts or the amounts of the hydrolysis suppressing agent may be determined depending on the targeted ultimate product. For example, the hydrolysis suppressing agent may be added in an amount not more than 20 parts by weight and preferably in an amount not more than 13 parts by weight based on 100 parts by weight of the organic high molecular weight compound.

There is no limitation to the method for preparing the resin composition of the present embodiment, such that any suitable known method may be used. Such a method consisting in melting the flame retardant additive and the hydrolysis suppressing agent and mixing the resulting product to the biodegradable organic high molecular weight compound may be recited as a preferred method for preparing the resin composition.

The method by melting and kneading is carried out by adding the flame retardant additive and the hydrolysis suppressing agent before or when melting the biodegradable organic high molecular weight compound and mixing the resulting mass. The flame retardant additive and the hydrolysis suppressing agent may be added simultaneously or separately. If the flame retarder and the hydrolysis suppressing agent are added separately, any one of them may be added first. In an alternative method, the biodegradable organic high molecular weight compound is melted and thereafter the flame retarder or the hydrolysis suppressing agent is added and mixed. The resulting composition is re-melted together and the remaining one of the hydrolysis suppressing agent and the flame retarder is added and mixed. The hydroxide, phosphor-containing compound and the nitrogen compound, as the flame retardant additive, may be added simultaneously or separately. The flame retardant additive used may also be compounded of constituent components.

Please amend paragraph [0242] as follows:

As for the resin composition of the present embodiment, similarly to the aforementioned resin compositions, an active energy beam may be illuminated for suppressing hydrolysis of the biodegradable high molecular weight compound.

Please amend paragraph [0244] as follows:

The active energy radiation may be illuminated using known devices. These devices may be enumerated by UV illuminating devices and electron accelerators. There is no particular limitation to the dose of illumination and illumination intensity as long as the hydrolysis of the biodegradable high molecular weight compound is effectively delayed within the range of the dose of illumination and illumination intensity value used. For example, in the case of the electron beam, it is preferred that the acceleration voltage is of the order of approximately 100 to 5000 kV and the dose of the illumination is not less than approximately 1 kGy.

Please amend paragraph [0246] as follows:

With the resin composition, containing the biodegradable organic high molecular weight compound, the phosphorus-containing compounds, displaying high flame-retardant properties, when combined with the biodegradable organic high molecular weight compound, and the hydrolysis suppressing agent, it is possible to achieve compatibility between extremely high flame retardant properties, satisfying the range of from V0 to V1, when evaluation is made by e.g. a UV combustibility test, and excellent preservation characteristics, which will sufficiently assure the use of the resin composition as a feedstock for a casing for an electrical product.

Please amend paragraph [0247] as follows:

The molded product, formed of the resin composition of the present embodiment, is essentially composed of a biodegradable resin, which is a safe component for the living organism. This biodegradable resin may readily be decomposed in nature so that any adverse effects on the environment at the time of or after disposal may be diminished. Moreover, the flame-retardant additives, used in the present embodiment, exhibit high flame retardant properties and, after disposal, are decomposed into components which are not detrimental to the living organisms or the global environment, such as alumina, water or carbon dioxide. Hence, the flame-retardant additives have no adverse influences on the environment or on the human being. When the molded products are used for casings or packaging materials of the electrical products,

sufficient consideration has been taken for environment as compared to the case of employing pre-existing synthetic resins or biodegradable resins.

Please amend paragraph [0253] as follows:

As for kneading conditions, a MINIMAX-MIXRUDER, manufactured by TOYO SEIKI SHA, was used as a kneader. With the nozzle temperature set to 170 to ~~175°C, 175°C,~~ the torque set to 4 to 6 kg and with the time of residence set to three seconds or less, an additive was added to the resin by kneading. The resin composite material, thus produced, was pulverized, and subjected to press working at ~~170°C 170°C,~~ under a pressure of 300 kg/cm², to form a plate 1.0 mm in thickness. The plate was cut to measurement test pieces each of a size of 12.7 mmx12.7 mm. The composition of the test pieces of Examples 84 to 94 and Comparative Examples 21 to 24 are shown in Table 6.

Please amend paragraph [0267] as follows:

The molded product, prepared using the resin composition of the present embodiment, is required to possess preservation characteristics to a certain extent, for use as a molded article in e.g. a casing of an electrical apparatus, even though the molded product is biodegradable. In this consideration, the preservation characteristics at elevated temperature and humidity were evaluated. For this evaluation, each sample was preserved for 100 hours, at a temperature of ~~80°C 80°C,~~ and at a relative humidity of 80%, and the shape as well as the molecular weight of the sample after lapse of this time duration was measured. The same test pieces as those used in the above combustion test were used. The test pieces which were not problematical in shape and had a molecular weight upholding ratio from the pre-evaluation value of 80% or higher were evaluated o and those which failed to meet this requirement were evaluated x. The molecular weight was evaluated by the CPC (Gel Permeation Chromatography). The following Table 6 shows the results of the combustion and preservation tests of the Examples 85 to 94 and the Comparative Examples 21 to 24. Meanwhile, in the following table, [UL94-V1; o] denotes that the sample in question is the 94V-1 approved material, while [UL94-V1; x] denotes that the sample in question is not the 94V-1 approved material.